Doctoral thesis abstract

Light quality affects leaf pigments and leaf phenology

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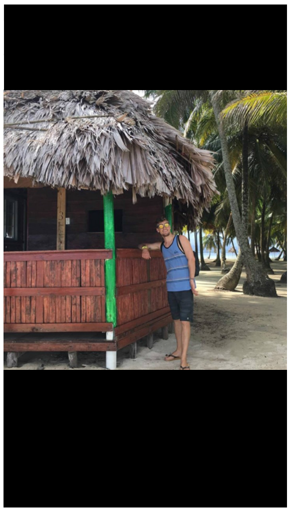
Bio of Craig C. Brelsford

Place of Birth: Poole, Dorset, UK
Biology BSc (Hons) 1st, University of Bristol
Research Technician at University of Cambridge in the Forest Ecology and Conservation Group

Short presentation I've always had a curious mind, and during my years at school I most enjoyed science, philosophy, and writing. I followed these through to University where I gained a 1st in Biology at the University of Bristol. After brief stints as a Field Biologist with the Mauritian Wildlife Foundation, and working with an ecological consultancy in the UK, I was given the opportunity to work as a Research Technician for Professor David Coomes at the University of Cambridge. It was this work—spending a memorable eight months of fieldwork in the jungles of Borneo—which harboured an appreciation for plants.

It was also during this time that when checking my emails I stumbled upon an advertisement for a PhD in Plant Biology at the University of Helsinki. Having wanted to try living in another European country, and not having a clue about Finnish culture, I naturally applied and was lucky enough to get the position.

Now having come through the other side, I can say that a PhD is a great opportunity to gain a range of skills suitable for a career within academia or outside. Throughout my PhD I found my biggest interests were in writing, learning to code, and teaching others. I now apply all of these in my current position as a Technical Writer and Instructional Designer. In short—I write and help produce interactive online courses for different companies. Our team helps teach topics on anything from software, to sustainability and engineering. It also means that I get to stay in Finland, and enjoy the important things in life such as going for walks in the forest, picking mushrooms, and hitting the sauna with friends.



PhD Thesis Abstract

Light quality varies in space and time, and plants are able to detect and respond to these environmental cues. Plants must time when their leaves come out in spring and fall off in autumn, to maximise opportunities for photosynthesis whilst conditions are favourable. Similarly, they must optimise the amount of sun-screening pigments in their leaves, to minimise the harmful effects of ultraviolet radiation at high irradiance.

Solar radiation reaching the Earth, as well as its composition, vary diurnally and seasonally with solar angle. During twilight, plants are able to detect changes in red:far-red light, and use this to help time their spring and autumn phenology. When forest canopies leaf out in spring, and cause canopy closure, the understorey becomes mostly covered in shade. This shade also causes a low red: far-red ratio, that plants are able to detect and increase their stem elongation. However, the amount of blue and UV radiation also varies in space and time, and we know considerably less about how plants

respond to these changes in the blue-and-UV region.

Using a combination of controlled indoor experiments, literature review, and manipulative field experiments, we set out four aims. 1) How do blue and UV-A radiation affect leaf pigments under controlled conditions? 2) How does blue light affect spring bud burst under controlled conditions? 3) How do blue and UV radiation affect leaf pigments and leaf phenology for understorey plant species? 4) How important is light quality as a phenological cue?

We found that both under controlled conditions and in the field, blue light had a large positive effect on the accumulation of flavonoids, most likely governed by cryptochrome photoreceptors. Interestingly, the flavonols in more light-demanding species of plants were more responsive to changes in light quality, particularly blue light. Similarly, blue light advanced spring bud burst in tree species both in the lab and in the field. We also report that both blue light and UV radiation can advance autumn leaf senescence in understorey plants. Lastly, when critically comparing the effect sizes of light quality treatments on phenological responses in trees, we found that light quality effects on spring phenology are generally small. However, the effects reported on autumn phenology are much larger. This adds to the complexity of drivers affecting autumn phenology, and may be one reason why autumn phenology is typically much harder to forecast compared to spring.

Future work should seek to understand how other environmental drivers such as temperature will interact with light quality to affect leaf pigments and leaf phenology. It will be important to understand how climate change could produce potential phenological mismatches in cues between the canopy and understorey, and even between different organisms such as plants, herbivores, and pollinators.

Publications in the thesis

Brelsford, C. C., L. Nybakken, T. K. Kotilainen, and T. M. Robson (2019). “The influence of spectral composition on spring and autumn phenology in trees”. In: *Tree Physiology* 39.6. Ed. by A. Polle, pp. 925–950. DOI: 10.1093/treephys/tpz026.

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Brelsford, C. C., M. Trasser, T. Paris, S. M. Hartikainen, and T. M. Robson (2019). “Understory light quality affects leaf pigments and leaf phenology in different plant functional types”. In: DOI: 10.1101/829036.

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